STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

JAMES B. HUNT JR.
GOVERNOR

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E. NORRIS TOLSON
SECRETARY

April 28, 1998

MEMORANDUM TO: Mr. Nicholas L. Graf, P.E.
FHWA Division Administrator

ATTENTION: Felix Davila
FHWA Area Engineer

FROM: David Robinson, Ph.D., P.E., Assistant Branch Manager DCR
Planning and Environmental Branch, NCDOT

SUBJECT: Design Noise Report for I-85 Greensboro Bypass From I-85, South of Greensboro, to West of SR 1392 (Drummond Road), Guilford County, F.A. Project # NHF-85-3(151), State Project # 8.U492301, TIP # I-2402 AA

DESIGN NOISE REPORT

The Design Noise Report for the subject project is attached for your review, recommendations, and comments. The Draft Design Noise Report was last reviewed by your office on March 23, 1998. The anticipated noise impacts and abatement measures for a subdivision located in the northeast quadrant of the interchange could not be adequately addressed at this time. The subdivision is located at the northern terminus of this project and at the southern terminus of the construction segment for U-2524 AB, that is in the design process. After sufficient information is developed for U-2524 AB, the subdivision will be evaluated to determine traffic noise impacts and appropriate noise mitigation measures. All other comments were addressed and incorporated into the document. The analysis was accomplished in accordance with Title 23 CFR, Part 772. Upon receipt of this approval, the report will be furnished to the Roadway Design Unit for their files and distribution to local officials.

If you have any question regarding this report, please contact Stephen Walker of the Environmental Unit of the Planning and Environmental Branch at (919) 733-7844. extension 277.

cc: Project File Walker

APPROVED

5/4/98 Roy C. Shelton
DATE FOR NICHOLAS L. GRAF
DIVISION ADMINISTRATOR

DESIGN NOISE STUDY REPORT
for the
I-85 Greensboro Bypass
Section AA

NCDOT Project 8.U492301
TIP I-2402AA
FAP NHF-85-3(151)

Prepared for:

NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS

April 1998

Prepared by:

Gannett Fleming
ENGINEERS AND PLANNERS

Gannett Fleming
ENGINEERS AND PLANNERS

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April 17, 1998

H. Franklin Vick, P.E., Manager
Planning and Environmental Branch
Division of Highways
N.C. Department of Transportation
Transportation Building, Room 462
1 South Wilmington Street
Raleigh, N.C. 27611

ATTENTION: Mr. Stephen E. Walker
Traffic Noise/Air Quality Section

RE: **DESIGN NOISE REPORT**
I-85 Greensboro Bypass, Design Section AA - Guilford County
From I-85, South of Greensboro to West of SR 1392 (Drummond Road)
Project 8.U492301; FAP Project NHF-85-3(151); TIP I-2402AA.

Gentlemen:

The Design Noise Report for the I-85 Greensboro Bypass, Design Section AA, is submitted to the Traffic Noise/Air Quality Section. The report contains minor revisions incorporated subsequent to FHWA review. The analysis was conducted in accordance with Title 23 CFR, Part 772, and NCDOT Noise Abatement Guidelines.

Should you have any questions regarding this report, please contact me at (717) 763-7211, extension 2428, or Daniel Farber at (717) 763-7211, extension 2613. We appreciate this opportunity to be of service to the North Carolina Department of Transportation on the Greensboro Bypass project and look forward to working with you on future projects.

Very truly yours,

Daniel W. Farber

for David R. Still, Manager
Transportation Noise/Air Quality Analysis

cc: Project I2402AA File

PROJECT LOCATION/DESCRIPTION

Design Section AA of the proposed I-85 Greensboro Bypass includes the construction of a freeway on new location from I-85 south of Greensboro to west of SR 1392 (Drummond Road), a distance of approximately 2.6 km. Design Section AA will consist of the construction of a major interchange with existing I-85, and will also include improvements to I-85 north and south of the interchange. Access will be fully controlled on the facility and the design speed is 110 km/h (70 m/h).

PROCEDURE

The highway traffic noise prediction requirements, noise analyses, noise abatement criteria, and requirements for informing local officials constitute the noise standards mandated by 23 CFR 772. All highway projects which are developed in conformance with this directive are deemed to be in conformance with the Federal Highway Administration (FHWA) noise standards.

The purpose of the FHWA procedures is to provide for noise studies and noise abatement measures to help protect the public health and welfare, to supply noise abatement criteria, and to establish requirements for information to be given to local officials for use in the planning and design of highways.

As part of this evaluation, current existing noise levels were measured in the vicinity of the proposed project. Predictions were also made of the maximum design peak hour Leq traffic noise levels expected to occur at sensitive receptor locations in the vicinity of the project. The procedure used to predict future noise levels in this study was the FHWA Noise Barrier Cost Reduction Procedure, STAMINA 2.0 and OPTIMA (revised March 1983). The BCR (Barrier Cost Reduction) procedure is based upon FHWA Highway Traffic Noise Prediction Model (FHWA-RD-77-108).

CHARACTERISTICS OF NOISE

Sound is measured and described by units called decibels. Decibels are units which represent relative acoustic *energy* intensities. Because the range of energy found throughout the spectrum of normal hearing is so wide (whispers to jet engines) the scale used to define these levels must be able to represent huge variations in energy. To compensate for this wide range of numbers, a base 10 logarithmic scale is used to make the numbers more "normal".

Noise is an undesirable or unwanted sound as subjectively perceived by the individual. Noise is emitted from many sources including airplanes, factories, railroads, power generating plants, and highway vehicles. Acceptance of a certain noise level may vary among neighborhoods, individuals, and by the time of day. Sound can affect all human activities and is often considered in local and regional land use planning.

Traffic noise is the sound generated by automobiles and truck operations on streets and highways. The sound generated is composed of tire, engine, and exhaust noise. People respond differently to acoustic energy in varying frequency ranges. Frequencies are airborne vibrations described in cycles/second, cps, or Hertz, Hz. The faster the vibration, the higher the frequency. The normal range of healthy hearing is from 30 cps (very low) to 16,000 cps (very high). The human ear is most efficient in the mid and high range frequencies and has increasingly reduced efficiency below approximately 250 cycles.

Sounds heard in the environment usually consist of a range of frequencies, each at a different level. The method of correlating human response to equivalent sound pressure levels at different frequencies is called *weighting*. The weighting system used to correlate human hearing to frequency response is the *A-weighting* scale and the resultant sound pressure level is called the *A-weighted sound pressure level*, identifiable by the abbreviated descriptor dB(A). Traffic noise levels are presented in decibels, using the A-weighting scale.

Throughout this report, references will be made to dBA, which means an A-weighted decibel level. Several examples of noise pressure levels in dBA are listed in Table 1. Review of Table 1 indicates that most individuals in urbanized areas are exposed to fairly high noise levels from many sources as they go about their daily activities. The degree of disturbance or annoyance of unwanted sound depends essentially on three things:

1. The amount and nature of the intruding noise;

2. The relationship between the background noise and the intruding noise, and

3. The type of activity occurring when the intruding noise is heard.

In considering the first of these three factors, it is important to note that individuals have different hearing sensitivity to noise. Loud noises annoy some people more than others and some individuals may become angered if an unwanted noise persists. The time patterns of noise also enter into a person's judgement of whether or not a noise is objectionable. For example, noises occurring during sleeping hours are usually considered to be more objectionable than the same noises in the daytime.

With regard to the second factor, individuals tend to judge the annoyance of an unwanted sound in terms of its relationship to noise from other sources (background noise). The blowing of a car horn at night, when background noise levels are approximately 45 dBA, would generally be much more objectionable than the blowing of a car horn in the afternoon, when background noise levels might be 55 dBA.

The third factor is related to the disruption of an individual's activities due to noise. In a 60 dBA environment, normal conversation would be possible while sleep might be difficult. Work activities requiring high levels of concentration may be interrupted by loud noises while activities requiring manual effort may not be interrupted to the same degree.

Over a period of time, individuals tend to accept the noises which intrude into their daily lives, particularly if the noises occur at predicted intervals and are expected. Attempts have been made to regulate many of these types of noises including airplane noises, factory noise, railroad noise, and highway traffic noise. In relation to highway traffic noise, methods of analysis and control have developed rapidly over the past few years.

NOISE ABATEMENT CRITERIA

To determine if highway noise levels are compatible with various land uses, the FHWA has developed noise abatement criteria and procedures to be used in the planning and design of highways. These abatement criteria and procedures are in accordance with Title 23 Code of Federal Regulations (CFR), Part 772, U.S. Department of Transportation, FHWA, *Procedures for Abatement of Highway Traffic Noise and Construction Noise*. A summary of the FHWA Noise Abatement Criteria (NAC) for various land uses is presented in Table 2. Substantial increase, as defined by the NCDOT Noise Abatement Guidelines, is presented in Table 3. Sound pressure levels in this report are referred to as Leq(h). The hourly Leq, or equivalent sound level, is the level of constant sound which in an hour would contain the same acoustic energy as the time-varying sound. In other words, the fluctuating sound levels of traffic noise are represented in terms of a steady-state noise level of the same energy content. Also, one factor for considering traffic noise mitigation is when future noise levels either approach or exceed the criteria levels for each activity category. Title 23 CFR, Section 772.11(a) states, In determining and abating traffic noise impacts, primary consideration is to be given to exterior areas. *Abatement will usually be necessary only* *where frequent human use occurs and a lowered noise level would be of benefit.* For this project, all the identified receptors were residential, church, or commercial land use.

AMBIENT NOISE LEVELS

Ambient noise is that which results from natural and mechanical sources and human activity, and that which is considered to be usually present in a particular area. Ambient noise measurements were taken to quantify the existing acoustic environment and to provide a base for assessing the impact of future traffic generated noise levels from the proposed freeway on the receptors in the vicinity of the project. Field measurements were taken using a Bruel and Kjaer 2230 Precision Integrating Sound-Level Meter. The microphone was located at strategic points, 15 m from the near lane of travel and at an elevation approximately 1.5 m above the existing ground. A total of nine noise measurement sites were identified in the Greensboro Bypass Design Section AA project area. The ambient measurement sites and measured noise levels are presented in Figure 2 and Table 4, respectively.

The existing roadway and traffic conditions were used with the most current traffic noise prediction model in order to predict existing noise levels for comparison with measured noise levels. Comparisons were conducted at measurement sites 1, 2, 3, 4, 5, 8 and 9. Site 6 was located on a cul-de-sac within a mobile home park and site 7 was located along a roadway that carried insufficient traffic to conduct calibrations. The predicted existing noise levels ranged from 1.8 to 4.9 dBA higher than the measured noise levels at the three calibrated sites. Differences in dBA levels can often be attributed to "bunching" of vehicles, low traffic volumes, and actual vehicle speeds versus the computer's "evenly-spaced" vehicles and single vehicular speed.

The noise level of 52 dBA measured at a mobile home park to the west of I-85 near the Holden Road interchange (Measurement Site 6) was established as the ambient background noise level for the project area. At this background location, noise levels were comprised of distant traffic (especially truck tire noise) on I-85 and ramps, birds singing, occasional hammering and dogs barking in the distance. There were no vehicle passbys on local roads during the measurement period.

PROCEDURE FOR PREDICTING FUTURE NOISE LEVELS

The prediction of highway traffic noise is a complicated procedure. Generally, traffic is composed of a large number of variables which describe different vehicles driving at different speeds through a continually changing highway configuration and surrounding terrain. To assess the problem, certain assumptions and simplifications must be made.

The procedure used to predict future noise levels in this study was the Noise Barrier Cost Reduction Procedure, STAMINA 2.0 and OPTIMA (revised March 1983). The BCR (Barrier Cost

Reduction) procedure is based upon the FHWA Highway Traffic Noise Prediction Model (FHWA-RD-77-108). The BCR traffic noise prediction model uses the number and type of vehicles on the planned roadway, their speeds, the physical characteristics of the road (horizontal and vertical alignment, grades, cut or fill sections, etc.), receptor location and height, and, if applicable, barrier type, barrier ground elevation, and barrier top elevation.

Please note that only preliminary alignment was available for use in this noise analysis. The proposed roadways and intersections were assumed to be flat and at-grade. Therefore, the analysis represents the "worst-case " topographical conditions. Noise predictions made in this report were based on traffic conditions projected for the year 2015. Design hour volumes and truck percentages were derived from estimated 2015 ADT's and vehicle composition data provided by NCDOT's Traffic Forecast Unit. Design hour volumes were lower than level of service C volumes on all of the roadways studied within the project area. The speed of 105 km/h (65 m/h) was used for all future freeway predictions except on I-85 north of the proposed interchange. Currently the posted speed limit changes from 70 mph to 55 mph between Groometown Road and Holden Road on I-85. Future predictions between the proposed interchange and Holden Road were based on the current posted speed limit of 55 mph.

The computerized model was used to determine the number of land uses (by type) which would be impacted during the peak hour in the design year 2015. The basic approach was to select receptor locations at 7.5, 15, 30, 60, 120, 240, and 480 m from the center of the near traffic lane (adaptable to both sides of the roadway). The result of this procedure was a grid of receptor points along the project alignment. Using this grid, noise levels were predicted for each sensitive receptor identified along the project. Receptors predicted to approach or exceed the FHWA NAC or to experience an NCDOT substantial increase in noise levels were then analyzed in detail.

TRAFFIC NOISE IMPACT AND NOISE CONTOURS

Traffic noise impacts occur when the predicted traffic noise levels either: [a] approach or exceed the FHWA noise abatement criteria (with "approach" meaning within 1 dBA of the Table 2 value), or [b] substantially exceed the existing noise levels. The NCDOT definition of substantial increase is indicated in Table 3. Consideration for noise abatement measures must be given to receptors which fall into either category.

In accordance with NCDOT Traffic Noise Abatement Policy, the federal/state governments are no longer responsible for providing noise abatement measures for new development for which building permits are issued within the noise impact area of a proposed highway after the Date of Public Knowledge. The Date of Public Knowledge of the location of a proposed highway project will be the approval date of CEs, FONSIs, RODs, or the Design Public Hearing, whichever comes later. For development occurring after this public knowledge date, local governing bodies are responsible to insure that noise compatible designs are utilized along the proposed facility.

Detailed traffic noise exposures for noise sensitive receptors located in Section AA are listed in Table 5. Noise modeling was conducted in four segments A through D as noted below. Division of segments was based upon differences in traffic volumes and speeds.

A. I-85, south of the Greensboro Bypass.
B. Greensboro Bypass, east of I-85.
C. Greensboro Bypass, west of I-85.
D. I-85, north of the Greensboro Bypass.

The maximum number of receptors in each activity category that are predicted to become impacted by future traffic noise is shown in Table 6. These are noted in terms of those receptors expected to experience traffic noise impacts by approaching or exceeding the FHWA NAC or by a substantial increase in exterior noise levels. Under Title 20 CFR Part 772, there are 3 Category 'B' receptors along the bypass and 7 Category 'B' receptors along I-85 that are expected to experience traffic noise impacts in the project area. No Activity Category 'C' receptors are predicted to be impacted.. Along the proposed Greensboro Bypass, the maximum extent of the 72 and 67 dBA noise level contours are 67.5 and 110.6 m, respectively, from the center of the nearest travel lane. Along widened I-85, the maximum extent of the 72 and 67 noise level contours are 73.8 and 121.0 m to the north of the proposed interchange and 52.8 and 89.5 m to the south of the proposed interchange. Distances are measured from the center of the nearest travel lane. This information should assist local authorities in exercising land use control over the remaining undeveloped lands adjacent to the roadway within local jurisdiction. For example, with the proper information on noise, the local authorities can prevent further development of incompatible activities and land uses with the predicted noise levels of an adjacent highway.

Table 7 indicates the anticipated increase in exterior traffic noise levels for the identified receptors in each roadway section. When real-life noises are heard, it is possible barely to detect noise level changes of 2-3 dBA. A 5 dBA change is more readily noticeable. A 10 dBA change is judged by most people as a doubling or a halving of the loudness of the sound. Predicted noise level increases for this project are expected to be 7 dBA or less. No receptors would experience a substantial increase in noise levels (≥ 10 dBA) by the design year of 2015 as a result of the construction of the Greensboro Bypass Section AA.

TRAFFIC NOISE ABATEMENT MEASURES

If traffic noise impacts are predicted, examination and evaluation of alternative noise abatement measures for reducing or eliminating the noise impacts must be considered. Consideration for noise abatement measures must be given to all impacted receptors. There are 10 Activity Category 'B' receptors and no Activity Category 'C' receptor impacted due to highway traffic noise in the project area.

Highway Alignment Selection

Alignment selection involves the horizontal or vertical orientation of the proposed improvements in such a way as to minimize impacts and costs. The selection of alternative alignments for noise abatement purposes must consider the balance between noise impacts and other engineering and environmental parameters. For noise abatement, horizontal alignment selection is primarily a matter of citing the roadway at a sufficient distance from noise sensitive areas. The proposed construction of Design Section AB of the Greensboro Bypass has been evaluated to provide a balance among travel needs, safety of the motoring public, and other engineering and environmental parameters.

Traffic System Management Measures

The mission of the I-85 Greensboro Bypass transportation corridor is regionally significant in the efficient movement of people and goods. Traffic system management measures which limit vehicle type (e.g., heavy trucks), speed, volume, and time of operations, may be effective noise abatement measures. For this project, however, traffic management measures are not considered appropriate for noise abatement due to their adverse effect on the capacity and level-of-service of the widened freeway.

Past project experience has shown that a reduction in the speed limit of 10 mph would result in a noise level reduction of approximately 1 to 2 dBA. Because most people cannot detect a noise reduction of up to 3 dBA and because reducing the speed limit would reduce roadway capacity, it is not considered a viable noise abatement measure. This and other traffic system management measures, including the prohibition of truck operations, are not considered to be consistent with the project's objective of providing a high-speed, limited-access facility. These relationships among the change in sound pressure level, acoustic energy, and loudness are depicted in Table 8.

Noise Barriers

Noise barriers reduce noise levels by blocking the sound path between a roadway and noise sensitive areas. This measure is most often used on high-speed, limited-access facilities where noise levels are high and there is adequate space for continuous barriers. The range of feasible barrier attenuation (insertion loss or sound reduction) is presented in Table 9. Noise barriers may be constructed from a variety of materials, either individually or combined, including concrete, wood, metal, earth and vegetation.

For a noise barrier to provide sufficient noise reduction it must be high enough and long enough to shield the receptor from significant sections of the highway. Access openings in the barrier created by driveways or intersections severely reduce the noise reduction provided by the barrier. It then becomes economically unreasonable to construct a barrier for a small noise reduction. For example, an observer (receptor) located 15 m from the barrier would normally require a barrier 120 m long. An access opening of 12 m (10 percent of the area) would limit its noise reduction to approximately 4 dBA (*Fundamentals and Abatement of Highway Traffic Noise*, Report No. FHWA-HHI-HEV-73-7976-1, USDOT, chapter 5, section 3.2, page 5-27). Hence, these factors would not allow noise walls to be acceptable abatement measures along the right-of-way that is not controlled. Additionally, pedestrian and motorist safety at noise barrier access openings (driveways, crossing streets, etc.) is of primary concern due to the restricted sight distance from the observer to oncoming traffic.

In order for a noise barrier to be considered feasible, it must meet, among other factors, the following conditions:

1. Provide a minimum insertion loss of 6 dBA, preferably 8 dBA or more (for receptors directly adjacent to the project);

2. Result in an acoustic environment where no other noise sources are present; and

3. Be feasible to construct given the topography of the location.

A primary consideration of the reasonableness of noise barrier installation is that it costs no more than $25,000 per receptor benefitting (those impacted or non-impacted receptors receiving 4 dBA or more reduction).

Due to traffic noise impacts predicted to occur by the design year 2015, a noise barrier evaluation was conducted for this project. The evaluation consisted of a qualitative analysis conducted at the locations listed below. Consideration was given to the FHWA NAC activity category at each receptor, source-receptor relationships, impacted site densities, and the ability to have continuous barriers.

Qualitative Analysis:

- Receptors 1 through 3: Three residences located east of I-85 would be impacted primarily because of noise from increased traffic on SR 1129 (Groometowne Road). Mitigation would not be reasonable because of the need to maintain access to driveways for the impacted residences.

- Receptors 12 through 14: Three isolated receptors located west of I-85 and south of SR 1129 (Groometown Road) would be impacted by noise from increased traffic on widened I-85. Mitigation would not be reasonable because of the cost of abatement versus the benefits provided.

- Receptor 15: An isolated residence along SR 1129 (Groometown Road) would be impacted by combined noise from traffic on local roads and on I-85. Mitigation would be unreasonable due to the cost of abatement versus the benefits provided.

- Receptor 41, 42 and 44: Isolated residences are located along Wiley Davis Road west of the proposed Greensboro Beltway alignment. Combined traffic noise from the proposed beltway and Wiley Davis Road would impact receptors in this area. Mitigation would be unreasonable due to the cost of abatement versus the benefits provided. Also, a barrier placed along the beltway would not attain a minimum of 6 dBA because of unabated traffic noise on Wiley Davis Road.

CONSTRUCTION NOISE

The major construction elements of this project are expected to be pile driving, earth removal, hauling, grading, and paving. General construction noise impacts, such as temporary speech interference for those individuals living or working near the project, can be expected. Construction noise impacts may be particularly noticeable during paving operations, earth moving, and grading operations. Overall, construction noise impacts are expected to be minimal, since the construction noise is relatively short in duration and is generally restricted to daytime hours. Furthermore, the transmission loss characteristics of building shells are considered sufficient to moderate the interior effects of intrusive construction noise.

SUMMARY

Noise impacts are an unavoidable consequence of roadway projects. A total of 87 sensitive receptors were modeled for noise impacts in the Greensboro Bypass Section AA project area. Highway traffic noise impacts are predicted to occur at 10 FHWA NAC Activity Category "B" receptors as a result of the construction of the Greensboro Bypass Section AA. All impacted receptors are either single isolated residences or clustered in groups of approximately 2 to 3 residences. Mitigation would be unreasonable due to the cost of abatement versus the benefits provided. In addition, many residences are impacted by Y-line roadways that would make mitigation of the mainlines ineffective.

There appear to be no reasonable and feasible alternatives which meet NCDOT requirements for noise abatement measures in the project area. Hence, NCDOT does not recommend the construction of noise mitigation measures as part of this project. In lieu of physical noise mitigation measures, vegetative plantings could be provided for visual screening, contingent on funding, as a psychological mitigation measure during the final design of the project

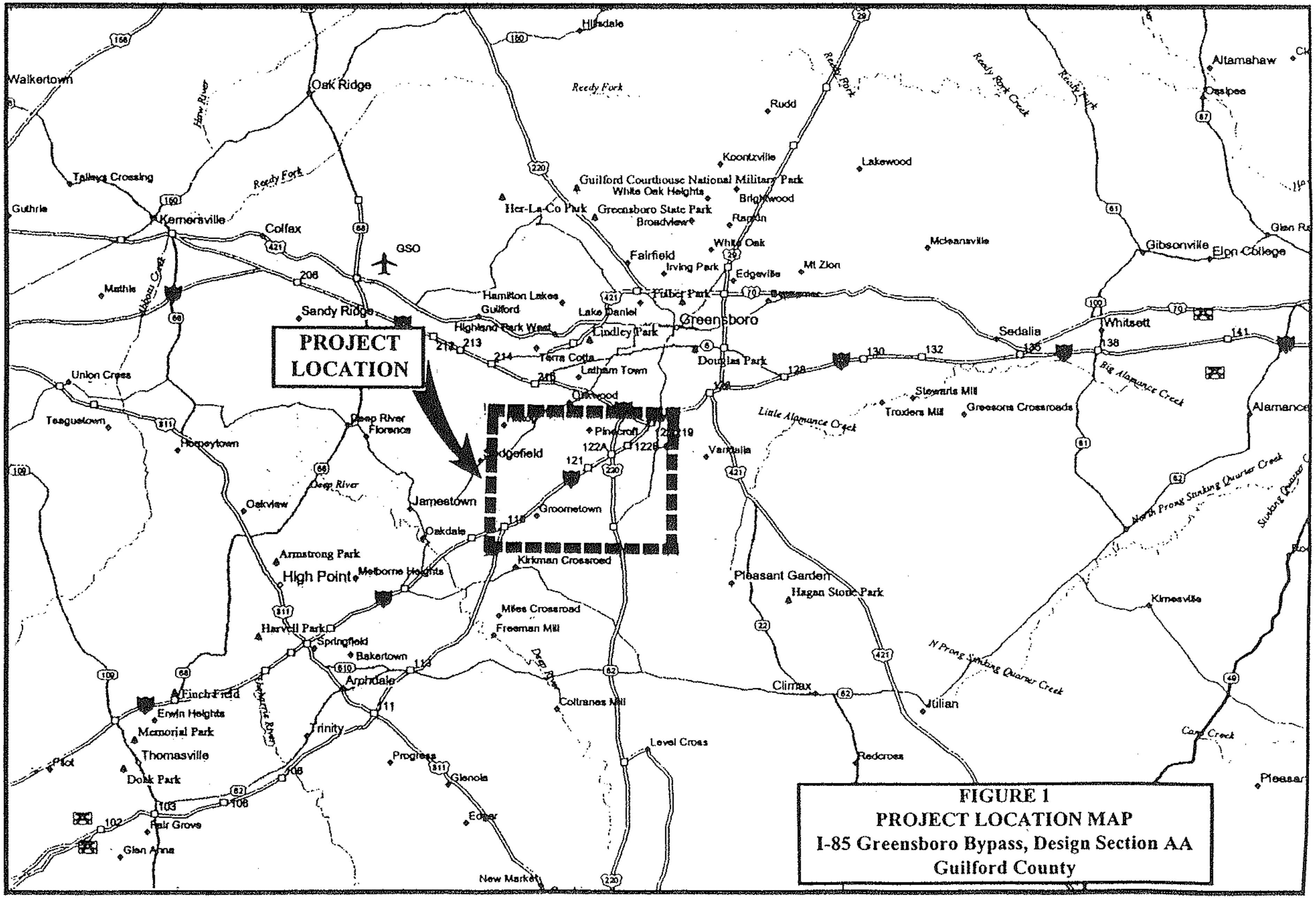

FIGURE 1
PROJECT LOCATION MAP
I-85 Greensboro Bypass, Design Section AA
Guilford County

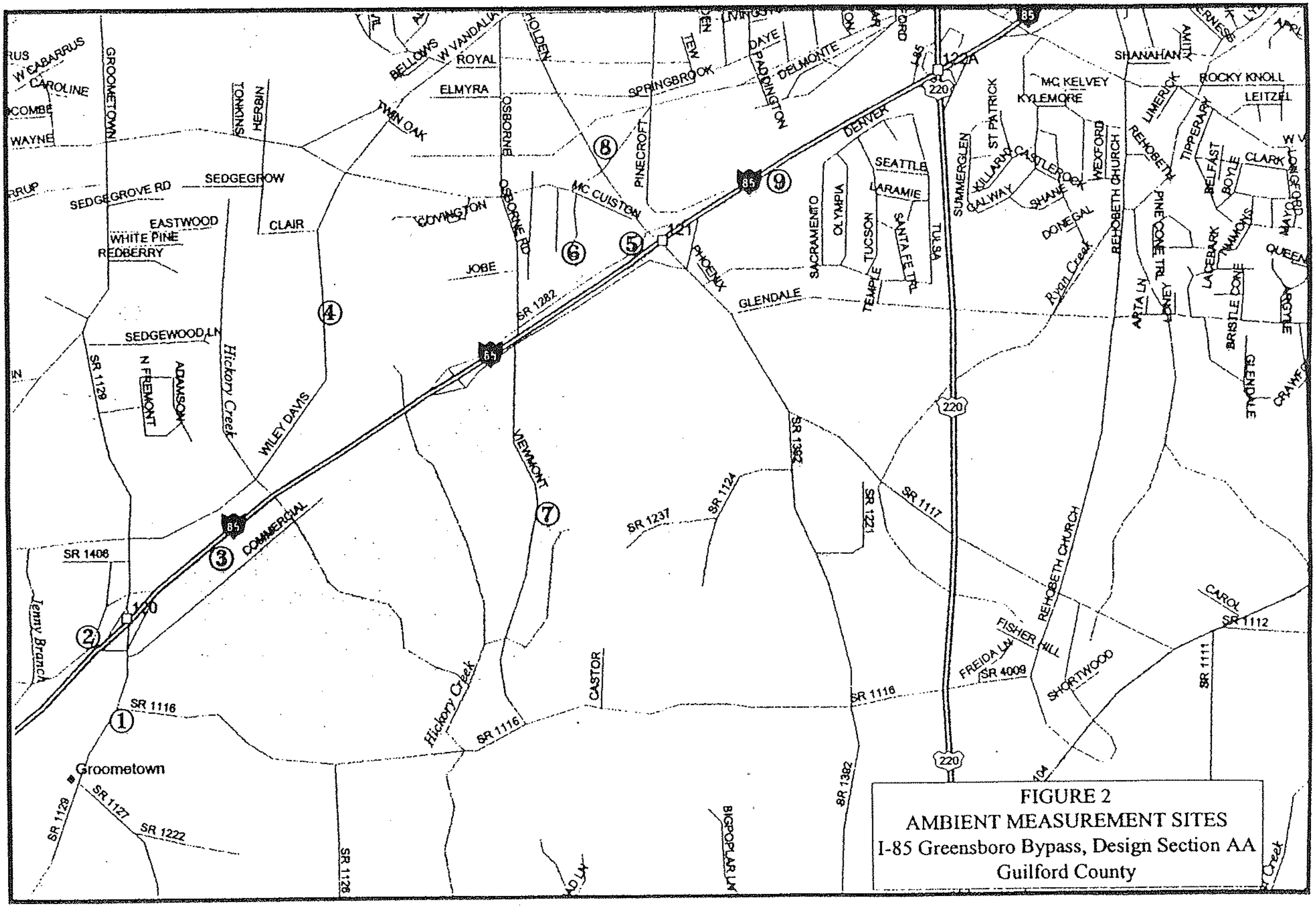

FIGURE 2
AMBIENT MEASUREMENT SITES
I-85 Greensboro Bypass, Design Section AA
Guilford County

Table 1
Hearing: Sound Bombarding Us Daily

OVERALL EFFECT	DBA	DESCRIPTION
PAIN	140	Shotgun blast, Jet 30 m away at takeoff Motor test chamber
THRESHOLD OF PAIN	130	Firecrackers
	120	Severe thunder, Pneumatic jackhammer Hockey crowd
UNCOMFORTABLY LOUD	110	Amplified rock music Textile loom
LOUD	100	Subway train, Elevated train, Farm tractor Power lawn mower, Newspaper press
	90	Heavy city traffic, Noisy factory Diesel truck 65 kph @ 15 m
	80	Crowded restaurant, garbage disposal Average factory, vacuum cleaner
MODERATELY LOUD	70	Passenger car 80 kph @ 15 m
	60	Quiet typewriter Singing birds, window air conditioner Quiet automobile
QUIET	50	Normal conversation, Average office Household refrigerator
VERY QUIET	40	Quiet office
	30	Average home Dripping faucet
AVG. PERSON'S THRESHOLD OF HEARING	20	Whisper @ 1.5 m Light rainfall, rustle of leaves
JUST AUDIBLE	10	Whisper
THRESHOLD OF ACUTE HEARING	0	

Table 2
Federal Highway Administration
Noise Abatement Criteria
Hourly A-Weighted Sound Level - Decibels (dBA)

Activity Category	$L_{eq}(h)$	Description of Activity Category
A	57 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need, and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries and hospitals.
C	72 (Exterior)	Developed lands, properties or, activities not included in Categories A or B above.
D	--	Undeveloped lands.
E	52 (Interior)	Residences, motels, hotels, public, meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

Source: *Procedures for Abatement of Highway Traffic Noise And Construction Noise*, 23 Code of Federal Regulations (CFR) Part 772; December 1991

Table 3
Definition of Substantial Increase
Hourly A-Weighted Sound Level - decibel (dBA)

Existing Noise Level in Leq(h)	Increase In dBA From Existing Noise Levels To Future Noise Levels
≤ 50	≥ 15
> 50	≥ 10

Source: North Carolina Department of Transportation Noise Abatement Guidelines.

Table 4
Summary of Existing Ambient Noise Level Measurements

Sect.	Location	Description	Date	Time[1]	Monitored Existing Noise Level dBA, Leq(h)
1	4524 Groometown Road	grassy area south of Winford Road	1/22/97	7:15 am	65
2	I-85, south of Groometown Road	grassy right-of-way	1/21/97	9:58 am	79
3	I-85, north of Groometown Road	grassy right-of-way	1/21/97	10:46 am	78
4	3921 Wiley Davis Road	grassy area next to residence	1/22/97	8:26 am	62
5	I-85, south of Holden Road	grassy right-of-way	1/22/97	9:20 am	76
6	Mobile home park, nw of I-85 at Holden Road	cul-de-sac	1/21/97	1:47 pm	52
7	4032 Viewmont Road	unpaved entrance to landfill	1/22/97	8:08 am	59
8	Holden Road at Springbrook Road	grassy wooded roadside	1/22/97	4:33 pm	67
9	I-85, north of Holden Road	grassy right-of-way	1/21/97	9:06 am	78

1. Time indicates start of measurement period. Measurements were 30 min. in duration at all locations.

Table 5
Greensboro Bypass
Design Section AA
Predicted Traffic Noise Levels Leq(h), dBA

A. I-85 SOUTH OF GREENSBORO BYPASS														
Receptor Information			Nearest Existing Roadway	Dist. (m)(1)	Ambient Noise Level(2)	Nearest Proposed Roadway	Dist. (m)(3)	Predicted Noise Levels			Impacts(4) Land Use Category			IOE
ID#	Land Use Category							L	Y	Total	B	C	E	
1	Residence	B	Groometown Road	24	66	I-85	207	60	66	67	*			1
2	Residence	B	Groometown Road	24	63	South of	228	59	66	67	*			4
3	Residence	B	Groometown Road	24	63	Greensboro Bypass	243	58	66	67	*			4
4	Residence	B	Groometown Road	34	60		249	58	63	64				4
5	Residence	B	Groometown Road	37	60		243	58	63	64				4
6	Residence	B	Groometown Road	37	60		276	57	63	64				4
7	Residence	B	Groometown Road	34	60		298	56	63	64				4
8	Residence	B	Groometown Road	31	61		280	57	64	65				4
9	Residence	B	Groometown Road	49	57		322	56	60	61				4
10	Residence	B	Groometown Road	55	56		334	55	59	60				4
11	Residence	B	Groometown Road	73	54		371	54	57	59				5
12	Residence	B	I-85	67	68		60	74	<40	74	*			6
13	Residence	B	I-85	98	64		91	70	<40	70	*			6
14	Residence	B	I-85	104	64		97	69	52	69	*			5
15	Residence	B	Groometown Road	31	63		139	65	64	68	*			5
16	Residence	B	Groometown Road	91	58		176	62	54	63				5
17	Residence	B	Groometown Road	128	56		200	61	51	61				5
18	Residence	B	Groometown Road	183	53		243	58	46	58				5
19	Residence	B	Groometown Road	110	54		267	58	52	59				5
20	Residence	B	Groometown Road	256	52		298	56	42	56				4
21	Residence	B	Groometown Road	37	61		197	61	63	65				4
22	Residence	B	Groometown Road	37	60		230	59	63	64				4
23	Residence	B	Groometown Road	37	60		252	58	63	64				4
24	Residence	B	Groometown Road	37	60		292	57	63	64				4

Note
1. Distance to centerline of near lane of existing roadway.
2. Shaded areas indicate receptors where ambient noise levels were adjusted up to 52 dBA, the existing ambient background noise level.
3. Distance to centerline of near lane of proposed roadway.
4. * indicates traffic noise impact (per 23 CFR Part 772).

Table 5
Greensboro Bypass
Design Section AA
Predicted Traffic Noise Levels Leq(h), dBA

A. I-85 SOUTH OF GREENSBORO BYPASS

Receptor Information			Nearest Existing Roadway	Dist. (m)(1)	Ambient Noise Level(2)	Nearest Proposed Roadway	Dist. (m)(3)	Predicted Noise Levels			Impacts(4) Land Use Category			IOE
ID#	Land Use Category							L	Y	Total	B	C	E	
25	Residence	B	Groometown Road	55	56	I-85	365	55	59	60				4
26	Residence	B	Groometown Road	67	56	South of	286	57	58	61				5
27	Church(5)	E	Groometown Road	49	32	Greensboro Bypass	316	31	35	36				4
28	Residence	B	Groometown Road	61	55		377	54	58	59				4
29	Residence	B	Groometown Road	61	55		432	53	58	59				4
30	Residence	B	Groometown Road	140	52		347	55	49	56				4
31	Residence	B	Groometown Road	202	52		389	54	45	55				3

Notes
1. Distance to centerline of near lane of existing roadway.
2. Shaded areas indicate receptors where ambient noise levels were adjusted up to 52 dBA, the existing ambient background noise level.
3. Distance to centerline of near lane of proposed roadway.
4. * indicates traffic noise impact (per 23 CFR Part 772).
5. Noise levels represent interior levels (FHWA Category E) and include a <u>25 dBA</u> insertion loss for <u>masonry</u> construction.

Table 5
Greensboro Bypass
Design Section AA
Predicted Traffic Noise Levels Leq(h), dBA

B. GREENSBORO BYPASS, EAST OF I-85															
Receptor Information			Nearest Existing Roadway	Dist. (m)(1)	Ambient Noise Level(2)	Nearest Proposed Roadway	Dist. (m)(3)	Predicted Noise Levels			Impacts(4) Land Use Category			IOE
ID#	Land Use Category							L	Y	Total	B	C	E	
32	Residence	B	Viewmont Road	21	52	Greensboro Bypass	244	57	<40	57				5
33	Residence	B	Viewmont Road	24	52	East of US 220	287	56	<40	56				4

Notes
1. Distance to centerline of near lane of existing roadway.
2. Shaded areas indicate receptors where ambient noise levels were adjusted up to 52 dBA, the existing ambient background noise level.
3. Distance to centerline of near lane of proposed roadway.
4. * indicates traffic noise impact (per 23 CFR Part 772).

Table 5
Greensboro Bypass
Design Section AA
Predicted Traffic Noise Levels Leq(h), dBA

C. GREENSBORO BYPASS, WEST OF I-85															
Receptor Information			Nearest Existing Roadway	Dist. (m)(1)	Ambient Noise Level(2)	Nearest Proposed Roadway	Dist. (m)(3)	Predicted Noise Levels			Impacts(4) Land Use Category			IOE
ID#	Land Use Category							L	Y	Total	B	C	E	
34	Residence	B	Wiley Davis Road	21	59	Greensboro Bypass,	189	61	62	65				6
35	Residence	B	Wiley Davis Road	24	59	North of I-85	183	61	62	65				6
36	Residence	B	Wiley Davis Road	21	59		183	61	62	65				6
37	Residence	B	Wiley Davis Road	24	59		183	61	62	65				6
38	Residence	B	Wiley Davis Road	18	60		183	61	63	65				5
39	Residence	B	Wiley Davis Road	21	59		183	61	62	65				6
40	Residence	B	Wiley Davis Road	27	58		171	62	61	65				7
41	Residence	B	Wiley Davis Road	18	60		149	64	63	67	*			7
42	Residence	B	Wiley Davis Road	12	62		262	57	65	66	*			4
43	Residence	B	Wiley Davis Road	67	52		293	56	53	58				6
44	Residence	B	Wiley Davis Road	15	62		238	58	65	66	*			4
45	Residence	B	Wiley Davis Road	34	56		253	57	59	61				5
46	Residence	B	Wiley Davis Road	37	56		259	57	59	61				5
47	Residence	B	Wiley Davis Road	43	54		262	57	57	60				6
48	Residence	B	Wiley Davis Road	24	59		244	57	62	63				4
49	Residence	B	Wiley Davis Road	34	56		259	57	59	61				5
50	Residence	B	McCuiston Road	226	52		274	56	<40	56				4
51	Residence	B	McCuiston Road	244	52		366	54	<40	54				2

Notes
1. Distance to centerline of near lane of existing roadway.
2. Shaded areas indicate receptors where ambient noise levels were adjusted up to 52 dBA, the existing ambient background noise level.
3. Distance to centerline of near lane of proposed roadway.
4. * indicates traffic noise impact (per 23 CFR Part 772).

Table 5
Greensboro Bypass
Design Section AA
Predicted Traffic Noise Levels Leq(h), dBA

D. I-85 NORTH OF GREENSBORO BYPASS															
Receptor Information			Nearest Existing Roadway	Dist. (m)(1)	Ambient Noise Level	Nearest Proposed Roadway	Dist. (m)(2)	Predicted Noise Levels			Impacts(3) Land Use Category			IOE
ID#	Land Use Category(4)							L	Y	Total	B	C	E	
52	Residence	B	I-85	323	52	I-85	323	53	<40	53				1
53	Residence	B	I-85	253	52	North of	253	55	<40	55				3
54	Church	E	I-85	174	30	Greensboro Bypass	174	34	<20	34				4
55	Residence	B	I-85	232	52		232	56	<40	56				4
56	Residence	B	I-85	250	52		250	55	<40	55				3
57	Residence	B	I-85	268	52		268	54	<40	54				2
58	Residence	B	I-85	210	52		210	57	40	57				5
59	Residence	B	I-85	250	52		250	55	40	55				3
60	Residence	B	I-85	226	52		226	56	43	56				4
61	Residence	B	I-85	216	52		216	57	43	57				5
62	Residence	B	I-85	204	53		204	57	42	57				4
63	Residence	B	I-85	192	53		192	58	42	58				5
64	Residence	B	I-85	186	54		186	59	42	59				5
65	Residence	B	I-85	168	55		168	60	41	60				5
66	Residence	B	I-85	146	57		146	62	42	62				5
67	Residence	B	I-85	177	54		177	59	43	59				5
68	Residence	B	I-85	177	54		177	59	43	59				5
69	Residence	B	I-85	162	55		162	60	44	60				5
70	Residence	B	I-85	155	56		155	61	44	61				5
71	Residence	B	I-85	140	57		140	62	45	62				5
72	Residence	B	I-85	140	57		140	62	45	62				5

Notes
1. Distance to centerline of near lane of existing roadway.
2. Distance to centerline of near lane of proposed roadway.
3. * indicates traffic noise impact (per 23 CFR Part 772).
4. The number of receptors represented by each modeled location are indicated in parenthesis.
5. Noise levels represent interior levels (FHWA Category E) and include a 25 dBA insertion loss for masonry construction.

Table 5
Greensboro Bypass
Design Section AA
Predicted Traffic Noise Levels Leq(h), dBA

D. I-85 NORTH OF GREENSBORO BYPASS															
Receptor Information			Nearest Existing Roadway	Dist. (m)(1)	Ambient Noise Level	Nearest Proposed Roadway	Dist. (m)(2)	Predicted Noise Levels			Impacts(3) Land Use Category			IOE
ID#	Land Use Category(4)							L	Y	Total	B	C	E	
73	Residence	B	I-85	152	56	I-85	152	61	46	61				5
74	Residence	B	I-85	166	55	North of	166	60	47	60				5
75	Residence	B	I-85	177	54	Greensboro Bypass	177	59	48	59				5
76	Residence	B	I-85	189	54		189	58	48	58				4
77	Residence	B	I-85	198	53		198	58	49	59				6
78	Residence	B	I-85	213	52		213	57	49	58				6
79	Residence	B	I-85	226	52		226	56	50	57				5
80	Residence	B	I-85	244	52		244	55	51	56				4
81	Residence	B	I-85	213	52		213	57	44	57				5
82	Residence	B	I-85	204	53		204	57	44	57				4
83	Residence	B	I-85	195	53		195	58	44	58				5
84	Residence	B	I-85	189	54		189	58	45	58				4
85	Residence	B	I-85	213	52		213	57	46	57				5
86	Residence	B	I-85	238	52		238	56	46	56				4
87	Residence	B	I-85	235	52		235	57	44	57				5

Notes
1. Distance to centerline of near lane of existing roadway.
2. Distance to centerline of near lane of proposed roadway.
3. * indicates traffic noise impact (per 23 CFR Part 772).
4. The number of receptors represented by each modeled location are indicated in parenthesis.

Table 6
FHWA Noise Abatement Criteria Summary

Description	Maximum Predicted Leq Noise Levels (1)			Contour Distance (maximum)(2)		Approximate Number of Receptors Impacted According To Title 23 CFR Part 772				
	15m	30m	60m	72 dBA	67 dBA	A	B	C	D	E
I-85, south of Greensboro Bypass	83.7	79.5	74.1	73.8	121.0	0	7	0	0	0
Greensboro Bypass, east of I-85	82.6	78.5	73.1	66.9	109.5	0	0	0	0	0
Greensboro Bypass, west of I-85	82.8	78.6	73.2	67.5	110.6	0	3	0	0	0
I-85, north of Greensboro Bypass	80.6	76.5	71.0	52.8	89.5	0	0	0	0	0
Totals:						0	10	0	0	0

Notes:
1. 15m, 30m, and 60m distances are measured from center of nearest travel lane.
2. 72 dBA and 67 dBA contour distances are measured from center of nearest travel lane.

Table 7
Traffic Noise Level Increase Summary

Section	Exterior Increase In Noise Level At Sensitive Receptors							Substantial Noise Level Increase (1)	Impacts Due To Both Criteria (2)
	<=0	1-4	5-9	10-14	15-19	20-24	>=25		
I-85, south of Greensboro Bypass	0	21	10	0	0	0	0	0	0
Greensboro Bypass, east of I-85	0	1	1	0	0	0	0	0	0
Greensboro Bypass, west of I-85	0	5	13	0	0	0	0	0	0
I-85, north of Greensboro Bypass	0	14	22	0	0	0	0	0	0
Totals:	0	41	46	0	0	0	0	0	0

NOTES:
(1.) As defined by only a substantial increase (See Table 3).
(2.) As defined by both criteria in Table 2 and Table 3.

Table 8
Relationship Between Change In Decibel Level, Energy, and Loudness

Change In A-Level	Remove _% of Energy	Divide Loudness by _
3 dBA	50	1.2
6 dBA	75	1.5
10 dBA	90	2.0
20 dBA	99	4.0

Table 9
Barrier Attenuation

Reduction In Sound Level	Reduction In Acoustic Energy	Degree of Difficulty
5 dBA	70%	Simple
10 dBA	90%	Attainable
15 dBA	97%	Very Difficult
20 dBA	99%	Nearly Impossible